

Application no. 09/992,941
Amdt. Dated October 27, 2003
Reply to Office Action of June 27, 2003

REMARKS/ARGUMENTS

Claims 1,2, 6-9, and 11- 20 have been amended, claims 3-5 have been cancelled, Claims 1,2, 6-20 remain. In the Office Action of June 27, 2003, the Examiner has rejected claims 15-30 under 35 USC §112 ¶2 and indefinite. The Examiner has rejected claims 1-4, 10, 11, 15 and 16 under 35 USC §103(a) as being unpatentable over US Patent No. 5,633,712 to Venkatesh et al. (hereinafter "Venkatesh") in view of US Patent No. 5,867,268 to Gelikonov et al. (hereinafter "Gelikonov"). In addition, claims 6-9, 18, and 19 are rejected under 35 USC §103(a) as being unpatentable over Venkatesh and Gelikonov as applied to claims 1-4, 10, 11, 15 and 16 above, and further in view of US Patent No. 6,104,215 to Kempen et al. Also, claims 5, 13, 14 and 17 are rejected under 35 USC §103(a) as being unpatentable over Venkatesh et al. and Gelikonov et al. as applied to claims 1-4, 10, 11, 15, and 16 above and further in view of US Patent No. 5, 206, 924 to Kersey (hereinafter Kersey"). The Examiner has rejected claim 20 under 35 USC §103(a) as being unpatentable over Venkatesh, Gelikonov and Kersey as applied to claims 1-5, 10, 11 and 13-17 above, and further in view of Kempen. Also, claim 12 is rejected under 35 USC §103(a) as being unpatentable over Venkatesh and Gelikonov as applied to claims 1-4, 10, 11, 15, and 16 above and further in view of the prior art of Applicant's figure 1.

BRIEF SUMMARY OF THE INVENTION

An all-fiber Michelson white light interferometer is realized when the probe is located external to the interferometer. In this case, the light returning from a sample is sent to a scanning interferometer and then processed. A first embodiment of the all-fiber autocorrelator invention has the advantage of using a probe of arbitrary length without having to match the length of a probe fiber to the length of a reference fiber. Another advantage involves the use of lower-cost, single-mode, fiber to replace the polarization-maintaining fiber where no birefringence modulation degradation is experienced when Faraday rotator mirrors are used.

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An additional embodiment of the autocorrelator has an additional coherent optical source which co-propagates with the broadband light inside the scanning interferometer. Wavelength division multiplexors (WDMs) or other appropriate combining/splitting and filtering elements are used to inject and separate out the returns from the broadband and coherent sources. The detected fringe crossings from the coherent source are used to determine the exact displacement of the scan at all points in the sweep. The second embodiment of the all-fiber autocorrelator has features over the first embodiment that allow injection and separation of returns from a coherent source so that detected fringe crossings from the coherent source can be used to determine the exact displacement of the scan at all points in the sweep. The modified autocorrelator includes a broadband light source that provides white light at a center frequency through a fiber to a 50/50 coupler, or in applications that require low light loss, a three-port circulator. The coupler can include a termination on its unused leg. For this embodiment, the coupler and the single-mode fibers downstream therefrom as well as 50/50 fiber coupler form the main sensing light path of the autocorrelator.

REJECTIONS UNDER 35 USC §112 ¶2

In the office action mailed June 27, 2003, claims 15-20 were rejected under 35 USC §112 ¶2 for indefiniteness. Applicant respectfully submits that with the amendment to claim 15 herein, the lack of antecedent basis has been removed and the rejection under 35 USC §112 ¶2 should be withdrawn. With the withdrawal of the rejection of claim 15 under 35 USC §112 ¶2, the rejections for indefiniteness of dependent claims 16-20 should also be withdrawn.

REJECTIONS UNDER 35 USC §103(a)

In the above-cited office action, claims 1-4, 10, 11, 15, and 16 were rejected under 35 USC §103(a) as being unpatentable over Venkatesh in view of Gelikonov. Applicant respectfully submits that these references relate to all-fiber correlators using a broadband source and fiber stretchers but operate with the coherent reference wavelength and without the Faraday Reflectors disclosed in the instant application. Applicant

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respectfully directs the Examiner to Gelikonov, col. 2, line 60, where Gelikonov teaches that a fiber stretcher being fiber-wrapped cylinders will not work for the application of large scan fiber interferometers. A preferred embodiment of the present invention has a fiber stretcher being fiber wrapped cylinders, for example, piezoelectric cylinders. Because Gelikonov teaches away from the present invention, particularly considering the piezoelectric cylinders and rejecting them. Applicant respectfully submits Gelikonov should be withdrawn as a reference for the instant 35 USC §103(a) rejections. Applicant has amended claim 1 to include the limitations of dependent claims 3, 4 and 5 and has cancelled dependent claims 3, 4 and 5. The Applicant respectfully submits that with this amendment, claim 1 and claim 2 depending on claim 1 are unobvious in that the use of piezoelectric cylinders was neither taught nor discloses by the cited art.

In regards to the use of Faraday Rotator Mirrors (FRMs) to eliminate polarization fading, Kersey teaches the use of FRMs in fiber Michelson interferometers in order to "provide for passive elimination of polarization fading." The FRMs principal function of the several embodiments of the present invention is to eliminate the very large optical path dispersion, thereby causing coherence broadening, where the very large optical path dispersion is caused by very large birefringence modulation in turn caused by the significant physical movement of the PZT. While the FRM is also used to eliminate polarization fading, its key function in the several embodiments of the present invention is to eliminate the coherence broadening relying on a subtle relationship where the coherence broadening is caused by dynamic birefringence effects. Kersey teaches the use of FRMs for sensing applications using laser light sources and not broadband sources. The Applicant respectfully asserts that it is well known in the to those who practice in the field that FRMs only completely eliminate polarization fading at a single wavelength (i.e., such as that produced by a laser and not a broad band source). The Applicant submits this wavelength dependence is due to the nature of the polarization rotation capability of the magneto optic crystal used. Various wavelengths that pass thorough the device will experience different rotations. The Applicant respectfully asserts that the cited art neither suggests nor teaches that and FRM approach will work effectively for a broadband source especially when the light is significantly and rapidly modulated, in

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both phase and polarization, as is taught in the present application. The Applicant further respectfully asserts that is not obvious to those practicing in the field that the FRMs are effective for two wavelengths such as that taught in the present application where both 1300 nm and 1550 nm are used. Further, the present application illustrates that without following the teachings of the present invention, the very large birefringent modulation caused by the piezoelectric fiber stretchers, when used by single mode fiber, rendered fiber reflectometer designs useless due to coherence broadening and such designs needed to be constructed with PM fiber to overcome such errors. Accordingly, the Applicant respectfully submits that that the performance of the autocorrelator FRM configurations described as embodiments of the present invention in producing near transform limited resolution was unanticipated by those skilled in the art practicing at the time of the invention being conceived and reduced to practice and that Kersey neither teaches or suggests the two wavelength approach of the present invention in its several embodiments. Accordingly, Applicant respectfully submits that with the removal of Gelikonov and Kersy as bases for an obviousness rejection, claims 1, 2, 10, 11, 15, and 16 are presently allowable as are claims 13, 18, and 19 which were rejected as unpatentable over Venkatesh and Gelikonov in view of Kersey.

In the above-cited office action, claims 6-9, 18, and 19 were rejected under 35 USC §103(a) as being unpatentable over Venkatesh and Gelikonov as applied to claims 1-4, 10, 11, 15 and 16 above, and further in view of US Patent No. 6,104,215 to Kempen et al. (hereinafter "Kempen"). In relation to the use of an additional coherent source to accurately measured the scanned path length. The Applicant respectfully submits that Kempen teaches the use of a fiber optic Michelson using a short coherence source and a long coherence source. Unlike the preferred embodiments of the present invention, Kempen implements a Michelson as the sensor and preferably places a wavelength selective reflector in the light path prior to the probe. The embodiments of the present invention are significantly different from Kempen in that the present invention has both the coherent and incoherent light paths take exactly the same path. The Applicant submits that the cited art, as they relate to low coherence interferometry, does not

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disclose that the coherent source path is identical to the incoherent source path. Significant errors in path measurements can arise without following the teachings of the present invention where the coherent source path is identical to the incoherent source path. Kempen does not disclose embodiments or means to accommodate implementations where the coherent source path is identical to the incoherent source path. The autocorreleator configuration of the present invention, using a coherent source to monitor the sweeping portion of the interferometer, is not prone to the differential draft errors of Kempen. Applicant respectfully submits that there is no suggestion to take Kempen together with Venkatesh and Gelikonov and resubmits that Gelikonov should be removed as a reference for purposes of an obviousness rejection under 35 USC §103(a). Further, based on the forgoing, the applicant respectfully submits that Kempen should be removed as a reference for purposes of an obviousness rejection under 35 USC §103(a) and accordingly, Claims 6-9, 18 and 19 be allowed as should be claim 20 as applied to claims 1-5, 10, 11, and 13-17, which was rejected as unpatentable over Venkatesh, Gelikonov and Kersey in view of Kempen and as should be claim 12 which was rejected as being unpatentable over of Venkatesh and Gelikonov as applied to 1-4, 10, 11, 15, 16 and further in view of the prior art of Applicant's Fig. 1.

Amendments to Correct Punctuation, Grammar and Misspellings

Claims 1, 13, 14, and 15 have each been amended to correct the spelling of "through." Claim 1 has been amended to enter an indefinite article before a first fiber means. Claims 2, 7 and 19 have each been amended to remove a colon. Claims 6, 18, and 20 have been amended to include a conjunction. Claim 8 has been amended to correct an indefinite article. Claim 12 has been amended to add an indefinite article. Claim 14 has been amended to remove a redundant phrase "further including." Claims 16 and 17 have been amended to correct the spelling of "includes." Claims 6, 18 and 20 have been amended to correct the means plus function language from "to couple" to "for coupling." So as to formally precise, dependent claims 2, 6-9, and 11- 14, and 16 - 19 have been amended to change "defined" to "claimed."

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Conclusion

The example configurations of the all-fiber scanning autocorrelator present the present invention in its several embodiments. This invention as claimed having all single-mode fiber, with or without a coherent optical reference, and having or otherwise utilizing probe leads of arbitrary length, advances beyond the prior bulk optic autocorrelator scan approaches and the teachings of all-fiber Michelson scanning technique that use piezoelectric fiber stretchers which regrettably are known to only function appropriately with "anisotropic" or polarization-maintaining fiber, and do not operate effectively with single-mode fiber.

In view of the above amendments and remarks, consideration and favorable action on claims 1,2, 6-20 are respectfully requested. Accordingly, Applicant respectfully requests that a timely Notice of Allowance be issued in this case. Should any question remain in view of his communication, the Examiner is encouraged to call the undersigned so that a prompt disposition of this application can be achieved.

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In addition to the Petition for an Extension of Time that accompanies this response, should there be any fees for this action, your office is authorized to draw from the firm deposit account number 02-3979. Should any question remain in view of this communication, I would appreciate a telephone call so that this matter may be resolved promptly.

Respectfully submitted,

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